THE AERONAUTICAL JOURNAL.

APRIL, 1899.

The Aeronautical Journal.

(PUBLISHED QUARTERLY.)

SUBSCRIPTION PER ANNUM (post free), 4s.

Communications respecting Advertisements to be addressed to the Publishers, "Aeronautical Journal,"

Messrs. KING, SELL, & RAILTON, Ltd., 4, Bolt Court, 12, Gough Square, and 4, Birchin Lane, E.C.

NOTICES OF The Aeronautical Society.

A Meeting of the Council was held on March 6th, when the following gentlemen were elected Members:—

Mr. OLIVER FIELD.

Rev. J. M. BACON (re-elected).

B. BADEN-POWELL, CAPT.,
Hon. Sec.

Meeting of the Aeronautical Society.

A meeting of the Aeronautical Society was held at the rooms of the Society of Arts, on Wednesday evening, 29th March.

Mr. C. F. POLLOCK was in the chair, and in opening the proceedings, called upon Mr. Percival Spencer, who he introduced as one of the best known aeronauts in England, to read the following paper on

ANDREE'S NORTH POLAR EXPEDITION.

Mr. SPENCER explained that most of the the details in this paper were extracted from the book entitled "Andree and his balloon," which was a very useful work, but in the English translation of it, many errors had crept in.

After the return of the Sir George Nares Expedition in 1876, the use of the balloon was suggested as a means of surmounting the obstacles in the way of reaching the regions of the North Pole.

My father—the late Charles Green Spencer—had a letter on the subject and a front-page illustration in the *Penny Illustrated Paper*, and subsequently Commander Cheyne suggested a scheme of reaching the Pole by means of triple balloons, which, however, never reached more than the theoretical stage, although he organized a subscription in this country and in America in order to carry it into effect. Other schemes have been suggested, and have appeared in the Press from time to time, but generally of a far too visionary and impracticable nature to be put into effect.

About 1894 the newspapers contained accounts of some balloon ascents in Sweden by Herr Andrée, on one of which trips he was blown across the Baltic Sea to Finland. It was shortly announced that he was contemplating an expedition with the idea of exploring the Polar regions by balloon. His scheme had the advantage of simplicity; he proposed to inflate a balloon with hydrogen gas as near as a ship could get, wait for a suitable wind, and then start with a view to crossing the Pole and continuing on until he reached inhabited regions on the other side. He proposed to keep the balloon near the surface of the earth by means of trail-ropes, so that he should be able to take observations in passing.

AN INTERVIEW WITH ANDREE.

In the summer of 1895 I saw Andrée in this country, and had an afternoon and evening's conversation with him on the subject of his proposed trip. He entered thoroughly into the matter. In connection with the use of the trail-rope in the Polar regions, my brother, who has been in Canada and witnessed the effects of the intense cold of a winter there, suggested that the rope was likely to freeze to the surface of the ground or ice and thus arrest the course of the balloon, to which Andrée at once replied that during the summer months at the Pole, the cold is not great, the sun is always up, and the temperature not below the freezing point, so that the surface of the ground remains damp and would never freeze to the rope. He pointed out that the constant sun and equal temperature was most conducive to the long duration of a balloon voyage. He had a very intelligent grasp of the subject of ballooning, discussed thoughtfully the various details of his equipment, and eventually adopted some of the suggestions I made in connection with his gear.

ANDREE'S FIRST EXPEDITION.

By the following year he had completed all arrangements of a financial and technical nature, and on the 7th June, 1896, embarked at Gothenburg on the steamer Virgo with balloon, gas apparatus, and

Messrs. Nils Strindberg, and Dr. Ekholm to be his companions in the car on the occasion of the most sensational balloon voyage ever attempted. The ship arrived at Spitzbergen on the 21st June. After a certain amount of exploring, a position on Dane's Island, adjoining the house erected by our fellow-countryman—the sportsman, Mr. Pike—was selected for the starting point, and the cargo was landed. A portable wooden shed, sufficiently large to protect the balloon from the wind, had been brought from Sweden, and the erection of this and other preliminaries consumed one month's time, and it was not until July 21st that the balloon shed and hydrogen gas-generating apparatus were ready. The balloon was inflated by the 27th July. All was now ready for the start, and it was only necessary to wait for a favourable breeze from the South. Andrée now experienced the discomforts of one who waits for the weather. A party of excursionists arrived to see the start, but departed after but a brief wait. Contrary winds prevailed with persistent continuance from the North, East, or West, but never from the South, which was the only direction of use. The captain of the Virgo informed Andrée that he must weigh anchor and depart shortly lest his ship be packed in the ice. Dr. Ekholm discovered that the leakage from the balloon amounted to nearly one per cent, per day, and expressed doubts as to its suitability for the purpose, although in my opinion it shows it to have been all that could be desired from a gas-holding point of view. After waiting 21 days in vain for a wind in a suitable direction it was decided to empty the balloon and postpone the ærial voyage until the following season. The balloon and portable accessories were reshipped, the shed and gas apparatus allowed to remain, and on the 20th August the Virgo started on the return voyage *en route* for Sweden. Thus ended the first season's expedition.

HIS SECOND EXPEDITION AND START.

During the winter's interval the balloon was somewhat enlarged. Dr. Ekholm retired from the venture, and Messrs. Frankel and Svedenborg took his place, the latter gentleman, however, only to ascend in case either of the other three were for any reason unable to do so.

On the second voyage the steamer "Svensksund," lent by His Majesty the King of Sweden, carried the party to Spitzbergen, leaving Gothenburg on May 18th, 1897, arriving at Danes' Island on May 30th. The balloon shed was found somewhat damaged by the weather, but was repaired and ready by June 12th, and the inflation of the balloon (which took 4 days) was finished by midnight of June 22nd, more than a month in advance of the previous year. Another tedious wait now occurred, winds from all directions except the right one, until, on July 11th, 1897, the start was made. The direction of the wind even then was not quite right, it was west of south, whilst a due south wind was necessary to carry the balloon to the North Pole.

The party in the car consisted of Messrs. Andrée, Frankel, and Strindberg, and at the time of start the wind was sufficiently strong to be heard "whistling through the woodwork of the shed and flapping the canvas which hung over the upper part."

Andrée prepared a telegram for the newspaper *Aftonbladet*, in which he said, "At this moment, 2.30 p.m., we are ready to start. We shall probably be driven in a north-north-easterly direction."

The only authentic news received since the start was a message from the aerial voyagers brought by pigeon, as follows:—"July 13th, 12.30 p.m., 82 deg. 2 min. north latitude, 15 deg. 5 min. east longitude. Good journey eastwards, 10 deg. south; all goes well on board.—ANDREE." This was received by the fishing boat "Alken" on July 22nd, between the Spitzbergen North Cape and the Seven Isles, in about 80 deg. north latitude. I, however, cannot place reliance upon the accuracy of either the date or else the latitude and longitude given, as I am confident that the balloon would have travelled a greater distance in 2 days.

SOME FACTS.

The distance from Dane's Island to the Pole is about 750 miles, and to Alaska on the other side about another 1,500 miles. The course of the balloon, however, was not direct to the Pole, but towards Franz Josef Land (about 600 miles) and to the Siberian Coast (another 800 miles). Judging from the description of the wind at the start, and comparing it with my own ballooning experience, I estimate its speed at 40 miles per hour, and it will therefore be evident that a distance of 2,000 miles would be covered in 50 hours, that is, 2 days and 2 hours after the start. I regard all theories as to the balloon being capable of remaining in the air for a month as illusory; no free balloon has ever remained up for more than 36 hours, but with the favourable conditions at the northern regions (where the sun does not set, and where the temperature remains equable) a balloon might remain in the air for double the length of time, which I consider ample for the purpose of Polar exploration.

MY OPINION AND THEORIES.

For some time after the ascent of the balloon, I was in anticipation of news from Siberia. I suggested the New Siberia Islands as a likely destination, but it is not at all unlikely that the Taimyr Peninsular would be reached. Those learned in the drift of air currents have pointed out to me that the high currents bear to the right of the direction of those nearer the ground. Andree started away to the east of north, with the trail ropes keeping the balloon near the earth. Now, if my experiments with the trail-rope and sail have proved anything, it is the certainty that the balloon will after a time lift the trail-rope off the ground and soar aloft into the upper regions, floating onwards with the wind for some time before returning to earth to permit the trail-ropes again to act. The only alterna-

tive to this would be that the increasing friction of the ropes, if not lightened by the discharge of ballast, would bear the balloon downwards until some obstacle in the way caused a rip in the fabric and put a premature end to the journey. When Andree's balloon lifted its trail-ropes off the ground and rose, as I anticipate, it would reach more westerly currents, and, therefore, drift to the east, and if the journey was continued for 50 hours at 40 miles per hour, would reach those parts of Siberia between Cape Taimyr and the Tunguska River, whence several rumours of discoveries have emanated.

Not having news from Siberia during the season 1897, I wondered whether the explorers had descended near Franz Josef Land and made for the Jackson-Harmsworth Settlement, where provisions had been left for them in case of need. It was evident that they would have to winter where they were, and no news was likely to come to hand before the 1898 summer season. Wellman's American Expedition has been to Franz Josef Land, and has sent news in the autumn of 1898 that there were no signs of Andree there.

There appears to me only two possibilities—first, that the descent has taken place on the Polar Ice Field, owing to the wind having proved insufficiently permanent to carry them on further and the life of the balloon being exhausted, and the explorers, having been unable to reach habitable land, have perished, for I doubt if they could pass through two Arctic winters; or, secondly, what I consider the most probable event, they have continued on to the Siberian Coast with the balloon, and descended when it would carry them no longer. In either case I expect they would have descended on or about July 14th, 1897; that is to say, not more than three days after the ascent.

I do not expect there would have been much difficulty with the landing, as the balloon was provided with a "rending flap," by means of which it could be rapidly torn open by pulling a cord immediately it touched the ground, thus speedily emptying it, and avoiding dangerous dragging, even in tempestuous weather. Finding themselves now on *terra firma*, if no inhabitants were visible, it is reasonable to suppose that the explorers would build up a house or cabin from the material of the balloon, using the booms to which the sail was fixed as tent poles, the waterproof silk as sides and roof, and the car—if they had still retained it—as an inside sleeping compartment. If no natives were visible they would probably organise extended tours to discover them, retaining their impromptu tent as a base of operations and return-there as occasion required. Weather and wild animals may have rendered any very extensive journeys impracticable. They were provided with but three months' provisions, and guns and ammunition, and if, during the time they were able to eke out an existence with these means, they discovered no natives with further supplies, only one end awaited them, starvation.

RUMOURS FROM SIBERIA.

There have been two reports from Krasnoyarsk, the first dated September 17th, 1897, that is two months after the start, as follows:—"On September 14th, at 11 p.m., the people in the village of Antzifirowskoje, which is in the district of Yeniseisk, saw the Andree balloon for the space of 5 minutes."

Investigations into this report led to no discovery being made, but on the principal that "where there is smoke there may be fire," I submit either that some natives had seen the Andree balloon some time previously to the date given, or they may have seen a pilot balloon sent up by the lost explorers with a view to communicating by this means with the outside world.

The second telegram from Krasnoyarsk, giving the circumstantial account of the discovery of a cabin of cloth and cordage apparently belonging to a balloon, the three human beings, and a number of scientific instruments, by Tunguses, a tribe inhabiting the Taimyr Peninsular, in Northern Siberia, leads me to the natural inference that this is the remains of the Andree North Polar Expedition.

Officials are reported to have proceeded to investigate on the spot, and many experts have given their opinion, generally of a sceptical nature. I consider that Siberia, north of Krasnoyarsk, is a most likely place of descent, and I wait the result of the fullest investigation of the tales and rumours of the Tunguses.

I consider an expedition to Greenland, to the west of Spitzbergen, which has been suggested, useless for the purpose of discovering the Andree balloon party.

SOME SUGGESTIONS FOR FUTURE NORTH POLAR EXPLORATION BY BALLOON.

Andree's Expedition having shown that there are no inherent difficulties in the way of making a balloon ascent in the icebound regions of the North, it may be as well to at once consider in what manner this means of transport may best be utilised in future. First, I do not think the balloon party should go alone on their own merits, but should form a part of a larger expedition. It is the usual plan for Polar expeditions to take ship as far north as possible, there to establish a base, and then for parties to push on by sledges drawn by dogs. In this manner the furthest north has been reached—Markham to 83 deg. 20 min. latitude, in 1876, and Nansen to 86 deg. 13 min. 6 sec., 1893 to 1896. Records show that much time is spent in slowly pushing northwards, and the return journey has to commence before great progress has been made. When, however, the return journey has commenced, great distances have been travelled in the return to the south. Now, given a south wind of moderate force, a balloon is capable of carrying the sledging party, with sledges, dogs

ammunition, and food, over all obstacles, and to the pole in a few hours, say the 650 miles from Franz Joseph Land, in about 20 hours, if the wind is blowing at 30 miles per hour, or in about 30 hours if the wind is blowing at 20 miles per hour. These are reasonable journeys for a balloon and such as have been accomplished on several occasions. Thus in about one day we can place a sledging party fresh and in good form at the Pole. They may make their observation, plant their flag, or carry out whatever other object they may have in view, and proceed at once on the return journey, having every inducement now to hasten on and rejoin their companions at their base of operations. This is a scheme which could have well been undertaken in connection with the Jackson-Harmsworth Expedition, which for several years was stationed at Franz Josef Land. The plan would then have been to start in the summer and go by the ship "Windward," which went out every year with supplies. Remain there with Jackson all through the long winter night, during which time practice ice travelling, and become acclimatised, and upon the arrival of light, when the sun rises for the long day, prepare the balloon and make all arrangements for the ascent on the first favourable opportunity. This plan gives a much better chance of success than that adopted by Andree, who arrived at his base somewhat late in the season, owing to the fact that a ship cannot penetrate through the ice until the season has well commenced and the ice sufficiently thawed. A suitable due South wind may have been prevailing for some time but had been of no avail as they were not ready. Having arrived at their base all was hurry and naturally the captain of the ship is anxious to return as soon as possible, and the ascent had to be made or abandoned within too short a time to give a reasonable expectation of a wind in the right direction. With the sledging party all ready and balloon at the permanent base, as I suggest, a start may be made immediately the atmospheric conditions favour, as early in the season as possible. In connection with the technical part of the undertaking, I have to suggest the following plan. Take the gas compressed in tubes, as used by the British Army Ballooning Corps. By this means the balloon can be inflated in a short time when the wind is in the right direction, and there is no need to inflate it a long time in advance, holding it tethered in its inflated condition through all sorts of weather like Andrée did.

This enables a lighter make of balloon to be used, which can carry a greater proportion of cargoe, because the balloon need not be strong enough to stand the buffeting about it would receive during its long wait.

It dispenses with the need of the enormous balloon house or shed, a windscreen only being necessary, and this is easily erected. As for the balloon, lightness, strength, and simplicity are its desiderata, and the avoidance of all untried accessories The number of trail-ropes used by Andree should be avoided as likely to become entangled, and one good long rope used which can be cut off from time to time and used as ballast and more lowered.

Andree's scheme was to float over the Pole, taking observations *en route*, and use the balloon as the vehicle by which to return, by continuing on until such time an inhabited country was reached. This necessitates a journey of more than 2,000 miles. My plan is to use the balloon to get to the Pole, and then abandon it and return by sledges. This means a balloon trip of 600 to 700 miles only—a much more likely distance to be practicable for the balloon.

The inaccessible regions of the North Pole may be reached by balloon if one has patience to wait for a suitable wind. Sledges, dogs, guns, ammunition, and food may be carried, and every means to enable the party to return. Whether that will be actually possible or impossible makes all the difference. Who will be the courageous person to take the risk, and obtain the honour if successful?

During the reading of the paper, a diagram of the Polar regions, as well as a number of photographs, kindly lent by Mr. Montefiore-Bryce, the Secretary of the Jackson-Harmsworth Expedition, were thrown on the screen.

The CHAIRMAN, in opening the discussion, mentioned that he did not himself see the practicability of carrying dogs and sledges in the balloon, unless it was a very large one. He quite agreed with the lecturer that it seemed impossible for a balloon to remain in the air for a great length of time, owing to variation in temperature. There is no doubt that a trail rope in trailing through water causes very great friction which has a tendency to pull the balloon down. Over ice the friction might be less. The alleged discovery of the bodies and balloon in Siberia did not seem in his opinion, likely, since, if the descent had been a rough one, one or other of the aeronauts would have been thrown out, and the bodies thus scattered over some distance.

CAPTAIN BADEN-POWELL pointed out that in the newspaper reports of the time, it was stated that the action of the trail ropes, was such as to cause Andree's balloon to take a direction if anything west of north, even though the wind was from the S. S.W. Perhaps this was not accurate, but anyhow the wind would be likely to change its direction after a time, and the locality of the descent must be very doubtful.

Mr. SPENCER said there was no difficulty in making a balloon large enough to carry the weight of all the men, sledges, dogs, food and amunition which the steamer brought. With reference to the direction the balloon is supposed to have gone, it is possible that the report referred to was that of those who *hoped* the balloon would go due north. The Captain of the "Windward" at Franz Joseph Land, kept a record of the direction of the wind on the days following the ascent, and found it day by day, to have varied between S.W. and N. W. It seems therefore, most probable that the balloon would have veered round to the right, towards Siberia.

Mr. ELWORTHY suggested that a number of balloons might be sent up from different places, and their exact direction noted. They could be numbered so that if found they could be recognised. Of course the difference of currents at varying elevations would have to be taken into account.

Mr. J. D. WHITE asked first whether it would not be better to do without a trail rope, which, though it regulated the height, also decreasd the speed of travel. Secondly, with regard to the cap covering the top of the balloon, was this to minimise the danger of a fall of snow? which would add a very great weight to the balloon. There would be a surface of perhaps 5,000 square feet, which could support a very considerable weight of snow. Could Mr. Spencer suggest any way out of this difficulty?

Mr. SPENCER replied with reference to the despatch of a number of pilot balloons, that he thought very few of them would ever be found again. They would generally be carried away by the lower currents, and observations on the clouds would probably be more suitable. With regard to trail-ropes, he thought there was a distinct drawback to them, since they slowed the speed. But it is very difficult to keep the trail-rope on the ground at all. Either the balloon lifts it off, or descends to the ground. A thousand feet of rope hanging from the balloon is a useful addition, as it prevents the balloon from coming down with a crash. The question of snow on the top is a very important one. The cap, of smooth material, was chiefly to keep the snow from lodging in the ledges formed by the net-work. It would be better in case of a snow fall, to rise above the clouds.

Mr. PILCHER asked what angle with the wind, the lecturer thought that Mr. Andree could get by using his sail.

Mr. SPENCER could only reply from personal experience. He had never been able to get a greater divergence than 3 degrees, and then it was impossible to keep the rope on the ground for more than say 5 per cent of the journey.

Mr. PILCHER asked if the weight of the gear would not have been better expended in ballast.

Mr. SPENCER said you could always get rid of rope or other gear, so you might just as well take it.

The CHAIRMAN then proposed a vote of thanks to the lecturer, which was carried by acclamation.

The Balloon as an Instrument of Scientific Research.

By REV. JOHN M. BACON, F.R.A.S.

A paper read at the Society of Arts on Wednesday, Feb. 15, 1899; Captain BADEN POWELL, Hon. Secretary to the Aeronautical Society of Great Britain, in the chair.

In the first years of the century, the Russian Academy organised, at St. Petersburg, what may be regarded as the earliest balloon ascent for genuine scientific research. One chief object which they had in view was to determine any difference in conditions existing at various altitudes above plain country as compared with those observed by Humboldt, Saussure, and others at like elevations on mountain heights, and that this is even still an important line of inquiry for which balloons are eminently well suited, I shall hope to make sufficiently clear. The experiments proposed, which, to-day, read quaintly suggestive, were to include an investigation of the power of solar rays, of the existence of electric matter, and of the intensity of the colours of the prism. No results of consequence, however, were obtained.

About the same period, Gay Lussac made experiments on the same lines at Paris, obtaining for the most part only negative results. Then a considerable interval elapsed before scientific ballooning was again seriously resumed, when the British Association instituted a series of experiments mainly by the use of captive balloons, but without any noteworthy success. A few years later, MM. Bixio and Barral made some interesting observations during lofty ascents chiefly on temperature variations, leading up to more important work in the same direction carried on in 1852 under the auspices of the British Association, when Mr. J. Welsh obtained results of considerable

value, which were published in the "Philosophical Transactions" in the following year. Some of the more remarkable of these I shall presently summarise, and endeavour to show that they suggest one important point which has perhaps scarcely received due attention.

It was practically at this stage that Mr. Glaisher took in hand those classical and exhaustive labours, which have found place in the front rank of scientific investigation of that date. The primary objects of his researches briefly put, were—To determine the temperature of the air and its hydrometric states at different elevations, and to investigate the distribution of water vapour below the clouds, in them, and above them. I proceed to present in outline certain of his more remarkable results for the purpose of bringing them into correlation with those of other aerial explorers.

Basing his deductions on 28 ascents, Mr. Glaisher was the first to prove clearly that the decrease of temperature with elevation is far from constant, as former theorists had asserted, and, moreover, that during midnight hours there is generally an increase of several degrees. In collecting results together he is careful to distinguish between clear and cloudy days, but it will suffice for my present purpose to show graphically the general law of decrease of temperature with height which he gives for clear day skies. In his own words, "the change from the ground to 1,000 feet was 6·2°, at 10,000 feet it was 2.0°, at 20,000 feet high the decline of temperature was 1.2°, at 30,000 feet high the whole decline of temperature was found to be 62.°." Having thus a formula, it becomes instructive to read it in the light afforded by individual and exceptional cases; but I would first compare it with the results, already alluded to, obtained by Mr. Welsh.

This observer, in my opinion, deserves more attention than seems to have been accorded to him. Hailing from Kew Observatory, he had the advantage not only of special training, but of the best instrumental equipment that could be furnished, and his observations give proof of having been successfully carried out with the most careful attention to all details. He made four afternoon ascents during summer and autumn, under clear as well as cloudy skies, and in all four his temperature readings show one very noteworthy characteristic which I shall first describe in his own words. "The temperature of the air," he says, "decreases uniformly with height above the earth's surface until at a certain elevation, varying on different days, the decrease is arrested, and, for a space of from 2,000 to 3,000 feet, the temperature remains nearly constant or even increases, the regular diminution being afterwards resumed, and generally maintained at a rate slightly less rapid than in the lower part of the atmosphere, and commencing from a higher temperature than would have existed but for the interruption noticed."

Let us look at this on a diagram drawn alongside Mr. Glaisher's general curve (Fig. 1). I

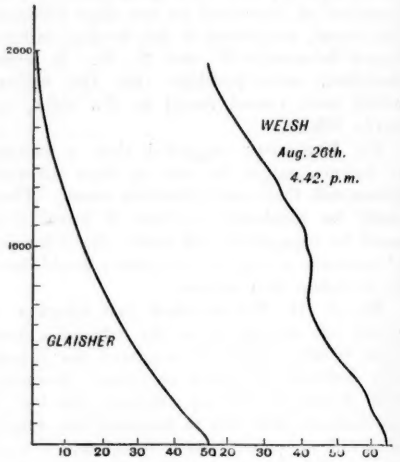

FIG. 1.

have taken a clear day in August, but the curve drawn would almost serve to illustrate each and all of Mr. Welsh's experiences. The remarkable halt he speaks of occurs in the clear air, commencing at 7,200 feet. Nine days previously, when the sun was constantly obscured, the bend in the curve commenced at 4,000 feet. On October 21, when he ascended in cloud and showers, the same bend occurs, but at 2,500 feet. Once more, on November 10, when he surmounted all cloud at 4,900 feet, the curve remains fairly regular until a height of 5,100 feet was reached, when, now well in the clear, the same remarkable check and recovery is recorded. This, I think, calls for further consideration, but returning for the present to Mr. Glaisher's account, we find him calling attention to a most instructive case which again can be illustrated by a simple figure.

It is now early spring, with wind from the S.E., the ascent commencing some two hours before sundown. The diagram explains itself, but the most important comment was supplied by Mr. Glaisher himself, who says:—"Our course was most remarkable. After passing over the Thames into Essex, we must have

re-crossed the river, and moved in an entirely opposite direction until we approached the earth again, when our direction was the same as at first." (Fig. 2.) And now, at this particu-

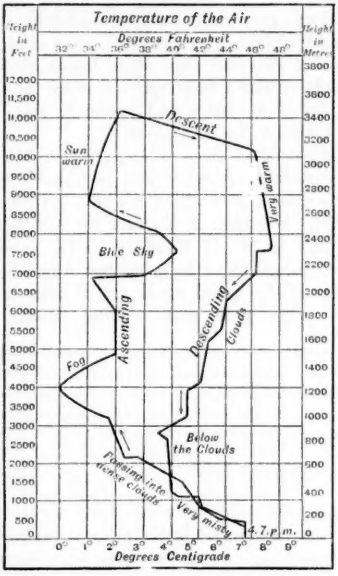

FIG. 2.

lar stage, let us compare these early results obtained by the balloon with typical diagrams prepared from recent records systematically taken by high-flying kites.

Here, under a clear sky, the decrease of temperature is practically regular up to a mile or more, but on an occasion where cloud was met the decline has been abruptly arrested. (Fig.3.)

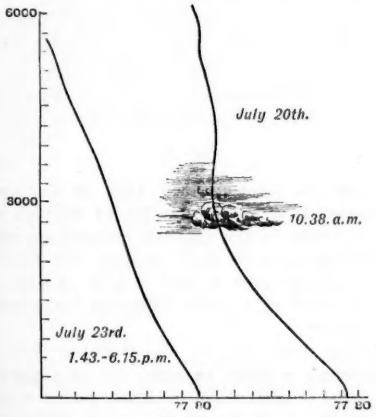

FIG. 3.

These curves accord well with those just considered, and point to an agreement in the two systems of observing, each method, however, performing its special function. The types of instruments used with kites should be noticed, and they may be considered scarcely of such a character as could respond very readily to rapid changes of temperature. Indeed, it has been customary to assume that five minutes are required to overcome the sluggishness of the instruments used, while, on the other hand, an observer in a free balloon can apply constant and needed corrections, as, for instance, by the use of a simple "sling" thermometer. Also, when the balloon is balanced, by a mercurial barometer; and he can read from moment to moment the fluctuations in a delicate air or other thermometer as he penetrates some shallow layer. Further, the kite-flyer clearly cannot, equally with the aeronaut, make sure of what is to be seen above the lowest cloud floor.

However, we can already duly interpret in the light of thirty years ago, as well as of to-day, a typical picture of our skies. Take a day in rainy July, as given by Mr. Glaisher, which, briefly described, reads thus:—Leaving a temperature of 618 on the ground, mist and then rain are quickly reached, and the first clouds left behind at 1,200 feet, where the temperature was 59°; further cloud is surmounted at 2,800 feet, the thermometer reading 548, then 558, and again 538; then with a smart descent dry fog is reached, growing wetter lower down, at a temperature of 57°; ascending again to 3,300 feet, the thermometer registered 53°, and finally getting down through squalls of wind and rain, the temperature of earth was found unchanged. Clearly it has not been established that visible cloud, and that alone, affects temperature in upper regions according to any fixed law. Humidity moreover has proved a very variable quantity, the most obvious law involved perhaps being that so commonly made patent to the eye, by familiar cumulus clouds forming in daytime at a height, say of from 3,000 to 6,000 feet, and disappearing again at night.

An all-important matter, however, which had up to this point been generally agreed upon by aerial observers, is that various currents are very commonly to be found flowing within definite but shifting beds, at all and varying heights until the dominant drift is reached. The prevalent trend of these greater streams was indeed seriously considered as long ago as the days of Green in England and Wise in America, both of these experienced

aeronauts having been prepared to essay a voyage across the Atlantic by a main upper current thought to prevail in the direction of the earth's rotation.

We can now with proper appreciation pass on to consider the work embraced in the scheme rapidly developing under the auspices of the international organisation now in active progress in other countries. Supplementing the work done by simultaneous ascents of captive and free balloons, we find that far beyond the limits of human endurance the unmanned or sounding balloons, despatched from large centres lying in the heart of extended country, having ascended and brought down self-registered readings showing altitudes and temperatures never dreamed of. The experiments with this class of balloon, which have been conducted at Berlin under the direction of Assmann, Berson, and others, have been as successful as they have been ambititious, and with a free balloon of 8,800 cubic feet, and possessing a net-lifting force of nearly 300 lbs., an altitude has been reached of upwards of 60,000 feet, as indicated by a barometric pressure of about 2 inches of mercury, while a temperature of –88° Fahr. was recorded. A temperature lower yet by 6° has also been recorded by a very similar balloon despatched from Paris.

Let us look first at some of the equipment of these balloons. The German instruments have been rendered extremely perfect by the use of photographic registration, and by mechanical ventilation of the aspiration apparatus. It will be supposed that a certain unavoidable lag attaches to any such instrument, temperature measurements reading too high in ascents and too low in descents, and it must also be observed that while the mean temperature of the whole mass of air is unknown, the altitudes, which are calculated on the well-known formula of Laplace, cannot be regarded as exact. Moreover, in spite of every possible precaution, it is open to question whether at extreme heights the registration can be relied on, and whether on that account the readings be not somewhat in error.

Balloons of the above description designed for high flights, being without controlling hand, are subject to certain disadvantages, among which must be mentioned the rapidity of vertical motion and the liability of the top of the balloon to become hollowed inwards by the pressure of the air as shown in the lantern slide. To obviate this an ingenious plan was devised by Capt. Kowanki, for automatically emptying ballast and dropping the bag. Other considerations affect this class of miniature aerial craft. M. de Fonvielle has recently pointed out that the ascending power of the free balloon is found to depend greatly on the character of the envelope by which the enclosed gas may be caused to maintain a considerably higher temperature than the surrounding air, and thus it is found that the altitude attained may vary as much as 6,000 feet between winter and summer, and 8,000 feet between day and night.

The result of these modern researches may be to modify somewhat that sectional drawing of the atmosphere which we have hitherto regarded. I submit a diagram for which I am indebted to M. de Fonvielle of the temperature readings given by a balloon sounding the depths of the aerial ocean up to some 42,000 feet. (Fig. 4) It goes without saying that

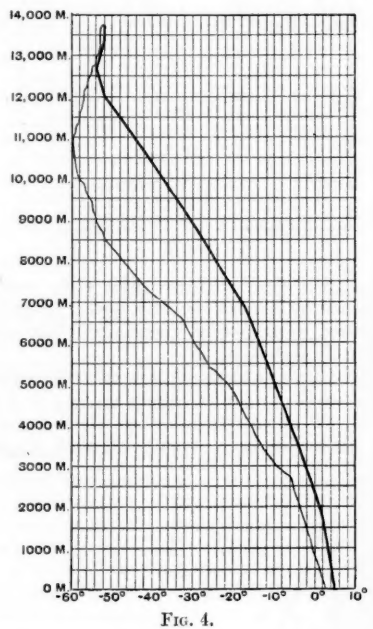

FIG. 4.

within the circumscribed area of our own country, it is hardly possible to compete on equal terms in the celestial competition now being organised on the Continent, but outside meteorology there is still a field as wide as the heavens open to the balloonist for scientific inquiry.

Many years ago, we find Professor Tyndall expressing a desire to make use of a captive balloon to determine whether sound waves travelling to windward may not be tilted over

the heads of observers; and it is with genuine disappointment that we read on and find that on communicating with Mr. Coxwell he learnt that the experiment was deemed too dangerous to be carried out.

Having the solution of this question as one chief end in view, I made arrangements for a series of right-away balloon ascents to take place during the past summer and autumn, and seven in all were carried out, under conditions differing as widely as a long-continued dry season would admit of, and including one night ascent at the end of September. Some observations were secured that at least, indirectly, throw light on the above question, but first other facts came more readily to hand. Professor Tyndall, in a series of laboratory experiments of great refinement, showed how in a tunnel or cupboard, which remained optically clear, the passage of sound was powerfully influenced by differences of temperature, whilst the densest fumes within these chambers offered no appreciable obstacle to sound waves so long as a uniform temperature was secured. I proceed to submit and illustrate as the outcome of my own aerial research, if not a fresh aspect of this matter, at least further considerations of the travel of sound in our own atmosphere. Broadly speaking, there have been days during the past summer, equally clear and brilliant (as judged of by the eye, or by photographs taken on the ground), when sounds travelling upwards have differed vastly in penetration. This has been tested in various ways. The heights have been carefully recorded when certain sounds have ceased to be audible, and these have very generally expired in their own due order. We find M. Flammarion stating that the whistle of a locomotive rises to near 10,000 feet, the noise of a railway train to 8,200 feet, the bark of a dog to 5,900 feet, the crow of a cock and the sound of a bell to 5,000 feet, and so on, but these records must be taken as mere averages, they may, on occasions, have to be added to or diminished by as much as one-half, even on such days as (so far as can be determined from earth, optically or by meteorological readings) have been practically indentical. Similarly, the test of echoes from earth, verified by constant repetition, have told the same tale. Another test tried with the same result has been an adjustable resonator applied to the ear and tuned to catch most readily the continuous murmur from earth, sometimes to be detected in this way, over a vastly extended vertical range.

The two series of pictures I proceed to show represent two days when acoustic conditions were normal, the photographs at all heights are equally and very unusually brilliant, but the noteworthy fact is that on one occasion the air up to 3,000 feet was unusually dry, and on the other was nearly as the point of saturation. The next two series of pictures were again taken in brilliant sunshine, as shown, and each were characterised equally by a blinding glare as seen from above, while acoustic conditions were then entirely at variance. As one proof of this, it may be stated that ground echoes throughout one voyage could not be heard anywhere at 1,000 feet, while on the other they were heard up to 2,500 feet. I would draw special attention to the glare to which I have alluded. It is presumably due to reflection off matter in suspension. Certain particles in the lower air present their sunlit surfaces to the observer or camera aloft, causing a dazzling reflection of light which admits of no mitigation, but which to the observer below has no existence. That these particles are other than those of water vapour would seem probable from the photographs I have shown. Are they dust?

I have made a great number of experiments to determine the presence of dust in the air during my balloon ascents by the use of an Aitken's dust-counter, and also by passing a known volume of air into samples of liquid, which have been subsequently compared. I have been driven to the conclusion that dust exists at different heights, and, as it would seem, not only in mere strata, but in discrete masses possibly comparable with visible clouds. I should have a similar remark to make with regard to the presence of carbonic acid. There appear to be more traces in certain tracts, and, as tending to bear out this view, I would add that I have made several series of uniform exposures with sensitive films with the object of testing the actinic qualities of light from the sky at different heights, and, so far as my experiments have gone, it would appear as if altitude were not the only factor in the case. In the clearest sky, and in the same quarter of it, it would seem as if clouds of some nature intervene perfectly transparent to the observer below, but offering resistance to certain waves of light and sound. Tracts of air relatively warmer are very commonly present above. During a night ascent, having armed myself with a delicate air-thermometer, to which I gave the closest attention, I found over different localities, and at many different heights, sheets or pools of air, often shallow, 12° or 15° warmer than the temperature of earth; and, from Mr. Welsh's records already

referred to, it is conceivable that something akin to an aerial gulf stream may for a whole season flow but a few thousand feet aloft.

Were an eye so constituted as to be able to see, say, cumulus masses of warmer air, strata mottled with traces of other gases, and beds of invisible matter in suspension, one might suppose that what we deem the clearest sky would then appear flecked with forms as many and various as the clouds that adorn our summer heavens.

With regard to motion in the atmosphere, it may be stated that if the loftier and broader streams of air are found confined within definite courses, it is common in lower levels to find the wind blowing in gusts that, as it were, break up aimlessly into wandering rills. This has been particularly noticeable in kite-flying experiments, before upper currents have been reached. I submit that we have an analogy here in the way in which a drop of ink, when falling through water breaks up into numerous curling streamlets. If we can picture gusts traversing by some such mode the lower strata of air, it becomes conceivable that these may be the vehicles that convey for a fleeting interval those fugitive sounds that appear for a moment to leap across great distances. These are well-known phenomena in balloon voyages, which I have studied with the conviction that, when borne upward, they are carried by ascending shafts of air leaning or wandering with the wind. A chance sound that has reached the silence above by a "long shot," has been noticed to come not so often overhead as to windward of its source. Other evidences, too, are not wanting of the erratic or sportive course of lesser currents. At upwards of 3,000 feet we have seen thistle down pass us from below, straying aloft on some unseen "up-draught." Again, we watch the cloudlet fray out in writhing wisps and twisting streamers betraying the wanton fluctuations of the stream that bears it. Professor Tyndall's observations in Hyde-park on the fitful hearing of the Westminster clock, though not made under very advantageous conditions, would support the view that the fickleness of distant sound may be in great measure due to the play of various currents. The ear was confessedly assailed by a tumult of other noise, but clearly also the air traversed was influenced by a multitude of intervening thoroughfares, blocks of buildings, and stacks of chimneys, which must have been the certain cause of conflicting currents.

Following up the experience gained in ballooning travel, I have lately made investigations of these fugitive sounds during continuous observations carried out through day and night hours on the Maplin lighthouse, standing far out at sea, and built on framework, against which there is no appreciable lap of water. Here sometimes the higher, and again sometimes the lower, galleries catch sounds more readily, and on one noteworthy occasion the first sounds heralding the approach of a distant steamer rose momentarily over an interval estimated at five miles. In this instance there could be no argument in favour of sound waves being tilted either upwards or downwards, and I conceive that the important question of the inaudibility of sounds at certain points within due range may need very searching investigation, in which the balloon must surely be an all-important instrument of research.

I would mention, in this connection, that in one recent voyage where the balloon lazily floated at low elevation, following the line of the Bath-road westward from Newbury, the voices of countrymen, and more particularly of children, were heard easily in our wake, over distances well exceeding a mile, the wind being very light, but a party of Tyrolese singers were unheard, though performing at no greater distance in a direction across the wind.

A very special advantage of researches made by an observer in a free balloon will always lie in the complete isolation of his observatory. He has command of a region of perfect silence and tranquility, and he has the power of altering his scope and station rapidly and without disturbance. Even the direction and rate of travel of the balloon is often under control to a very considerable extent, not so much by any method of guiding, which is very limited, and attended with obvious disadvantages, but by due observance and use of the variety of those currents already spoken of, which are often within reach. As far back as the historic voyage of the "Nassau" balloon, in 1836, Green's keen observation and admirable judgment enabled him by a masterly stroke of navigation to avoid being carried, at nightfall, out over the North Sea, and to hold his desired course across the straits of the Channel.

The track of one instructive balloon journey occurring in my own experience, and extending over the mere width of Sussex, will serve to further illustrate this point. In the Palace grounds the wind was so light that, at my suggestion, the heavy grapnel was left behind, so as to give us more lifting power, and with a lazy drift to the eastward we ascended by easy gradient to a height of 2,400 feet, by

which time we were over Penge, and maintaining the same direction. So also until we had reached 3,300 feet, and dropped again to 2,400 feet, at which point we were over Bromley and there entered a considerable current from the north-west. Steering then a fairly direct course with sundry fluctuations of height and direction, an altitude of 8,500 feet was reached near Hawkhurst, when, our course being rapid and nearly due south, we were quickly carried over Hastings old town. At this moment, though the management of the balloon was wholly entrusted to the unrivalled skill of Mr. Percival Spencer, I confess I was unable to see any way to avoid our dropping in the sea, save by trying conclusions among the forest of chimney-pots that already lay below us. But the discrimination of our aeronaut was prompt and unerring, and with a display of perfect judgment a descent was made to where the lower westerly current was once again encountered, now blowing stiffly along-shore, and we were thus brought-to near the verge of the cliffs, in the outskirts of Fairlight Glen.

But there are possibilities in the balloon for much other physical investigation, and this by virtue of the fact already insisted on, that in an aerostatic observatory, we may remove ourselves from all disturbing influence of earth. Mountain observatories may show an elevation of 4,000 feet and upwards, and even claim a certain freedom from radiation off the valleys, by reason of lower circumjacent fogs, but the very nature of a mountain is such that grosser air is attracted and hangs about its height, and, as a consequence of the neighbourhood of rock surfaces more or less heated, currents of local origin, even under most favourable conditions, must be constantly finding upward or downward passage on slopes of unequal and varying temperatures.

The force of the wind is another difficulty to be reckoned with. It was said at one time on Mount Hamilton that the wind often blew at the rate of 60 miles an hour, and that a greater velocity was never recorded only because at that point the anemometers carried away.

With the additional instrumental aid of properly designed spectroscopic and telescopic camaras, it is reasonable to hope that at high elevations we may penetrate with greater success than heretofore into the ultra-violet of the spectrum, and even under conditions of diminished air-glare to photograph the sun's corona without eclipse. It is easy to conceive how valuable experiments can be made when all that is "British" of the atmosphere is left below, dealing with questions of refraction and other problems; and, I think, we may go further and even venture to hope to put to a crucial test some of the markings on sister planets and other celestial wonders that have been elsewhere claimed as visible with very humble instruments, or else, by yet happier chance, to banish them for good beyond the limits of all controversy.

DISCUSSION.

The CHAIRMAN said they had had the most interesting details of Mr. Bacon's numerous ascents, especially as many of his experiments were of a nature quite unlike any previously made. The acoustical experiments were of special interest, and would no doubt prove to be of considerable importance. He could quite appreciate what had been said about the variability of gusts of wind, from his own experience with kites, though he was inclined to think there had been some exaggeration with regard to steady currents in different directions in the upper air. It seemed to him that if there were any great variety of currents, they would be shown by the clouds, and although occasionally they did see clouds moving in different directions, yet on ordinary occasions they all seemed to be going more or less the same way. He had watched the stream of highest cirrus in the region of the trade winds, and it was wonderful how steady the current seemed to flow in the opposite direction to the trades, though the motion appeared very slow, and would probably escape the notice of the ordinary observer, unless it were watched against some celestial body, such as the moon. He knew the difficulty there was in ballooning from not being able to depend on the current of air. On one occasion he made an ascent from Aldershot, with the intention of going to Ascot; the day was cloudy, but they got above the clouds, and, after a time, thinking they must be about over Ascot, descended, and found themselves on the other side of Guildford, having gone in almost exactly the opposite direction to what they intended. This led to the question of balloon steering, and he could not help referring to the latest reports with regard to the bold adventurers who started some two years ago to explore the Arctic regions. These reports seemed to have more semblance of truth than some previous rumours, and though it would be very sad if the death of those brave explorers were confirmed, it would be some satisfaction to have a record

of their journey. Several attempts had recently been made to test the principles adopted by Andree—of steering by a sail and a guide-rope—but, unfortunately, they had been rather meagre, and he hoped to take part soon in some more thorough tests of longer duration. But, after all, this method was somewhat rough and primitive; and what the public wanted to know was when there would be a really navigable balloon. There was, in his opinion, only one simple reason why that had not been attained, and that was that they could not get the needful money. Hitherto, all attempts had been on a very small scale, and the balloon of to-day might be compared to the coracle of the ancients. It was a small vessel, capable of lifting two or three men, and simply drifted with the current. Occasionally attempts had been made to propel a balloon against the wind, and on several occasions one had been propelled at the rate of some 14 miles an hour, but they were only small experiments in what we may call aerial canoes. They had recently read about the greatest attainment in modern shipbuilding, the *Oceanic*. He had made calculations, from which it appeared that if, instead of being an ocean liner, she had been an aerial vessel with a length of 700 ft. and a diameter of 70 ft., she would contain 2,500,000 cubit feet of hydrogen, and would lift a weight of 180,000 lbs. With due allowance for the weight of such a structure with engines of some 2,000 horse power, there would still be available lifting power to carry 200 passengers, or soldiers with their arms, and he could not see any insuperable difficulty in constructing a balloon of that size, with engines which would give a speed of 30 miles an hour. Even if such a vessel were dependent upon fine weather, would it not be most useful? He looked on these things from a military point of view, and he thought such an instrument would be of incalculable value not only in a European war, but for such purposes as fighting amongst the pathless mountains on the Indian frontier, or the swamps of Africa. They had heard a good deal lately about universal peace, but he thought this would be a solution of the difficulty, for if one nation possessed such powerful machines, she could dominate all others. England, by possessing a strong navy, was able to dictate to other nations, and she would be in a still stronger position if she possessed powerful machines capable of traversing the air. Perhaps this was rather diverging from the subject of the paper, but with regard to scientific research also, most extraordinary results would be attained by means of navigable balloons. If they had frequent reports of the state of the atmosphere at all heights, round the country and out at sea, practical meteorology would be very much assisted. All difficulties, too, of geographical research would disappear.

Admiral Sir Erastmus Ommanney, K.C.B., asked whether the magnetic compass retained its directive force at high elevations.

Mr. Percival Spencer said he had listened to the paper with the greatest pleasure, for though he had had the honour of accompanying Mr. Bacon on most of his ascents this was the first time he had seen the photographs. The meetings of the Aeronautical Society generally dealt with abstruse subjects more visionary than real, but here they had seen the actual results. The last time he was in that room it was to listen to an account of a flying machine by Mr. Davidson; it seemed to be a cross between a navvy's pick-axe and a blacksmith's anvil, and though the author demonstrated theoretically how well it would work, he was not aware that he had ever got an inch off the ground with it. In former days the Balloon Society dealt occasionally with this subject, but it had now ceased to exist, and given place to the Aeronautical Society, and he should like to see its discussions take a more practical turn. Mr. Bacon had shown how a balloon could be used as a floating observatory, and it was evident that a great deal could be done with balloons even as they existed at present. It was all very nice to talk about steering balloons, but there was one unfortunate point to be borne in mind. When in an ordinary balloon, going with the wind, you were in an absolute calm; but if an immense aerial machine such as the Chairman had described, were constructed, propelled with enormous force, all that would be changed, and the pleasures of ballooning would give way to the ordinary discomfit of a sea voyage. He well remembered how tranquilly he floated across to Havre recently in a balloon, and how in coming back by steamer, he was interrupted many times in writing his article for the *Times*, by occurrences which were anything but pleasant.

Mr. Eric S. Bruce thought one of the first things to be aimed at in balloon manipulation was an improvement in the power of vertical motion, so as to be able to rise without a sacrifice of ballast, and to descend without a sacrifice of gas. It had been said that ballast was the life-blood of a balloon, and it was quickly exhausted. It was, of course, a difficult problem, but he could not help thinking that Professor Dewar's achievements in

liquefying hydrogen might be turned to advantage. At any rate, this was the most important thing; the direction of horizontal motion was quite secondary. Mr. Bacon was to be congratulated on his efforts to explore the higher regions of the atmosphere, for meteorological science was being kept back from the want of men of sufficient heroism to trust themselves to a bag of gas; and it was a great pity that more systematic experiments could not be carried on in this direction. Mountain stations were always affected by terrestrial disturbances, and the value of isolated observations had been shown even in the case of the Eiffel Tower. He believed that the varying currents depended very much on the electrical condition of the atmosphere, for they were very frequent during thunderstorms. He had made a number of experiments in Switzerland with pilot balloons when thunderstorms were in progress, and found that numerous currents were flowing in different directions, though he had no instruments on the balloons by which the currents could be measured. The thanks of all interested in aeronautics were due to the Chairman for having practically resuscitated the Aeronautical Society. He had increased not only the number but the quality of the members; having persuaded some eminent men of science to join, and to take an interest in the subject, which must tend to stimulate invention and discovery.

Mr. G. FENTUM PHILLIPS thought Government ought to find the money necessary for constructing aerial machines. The nation which first possessed a navigable balloon would certainly be in a position to dictate to other powers; and such an achievement would be far more practical than any amount of talk about universal peace. When they saw governments like that of the United States or Great Britain spending a million and a-half on a battle-ship, which would be utterly useless in the presence of an aerial vessel, he thought the Government might reasonably be asked to vote a certain sum of money to a council formed of scientific men and engineers, to deal practically with this question. You could not expect a private individual, even if he were a millionaire, to devote half his life and the whole of his fortune to a project from which he would derive no benefit.

Mr. LEON GASTER said an ordinary sized balloon was quite sufficient for scientific research, and he did not think an immense structure, such as the Chairman had alluded to, rendered buoyant by gas, would be a practical machine. For the purposes he had in view, a flying machine would have a much better prospect of success.

The Rev. J. M. BACON, in reply, said with regard to the magnet, Mr. Glaisher had reached as great an altitude as anyone, and it was one of his favourite experiments to test the oscillations of the magnet under all circumstances. He had never recorded any failure of the directive power. His own instrumental equipment was so inadequate that he could not give any personal opinion on the question raised.

The CHAIRMAN then proposed a cordial vote of thanks to Mr. Bacon, which was carried unanimously, and the meeting adjourned.

A Method of Steering Balloons during Ascent and Descent.

By D. BIDDLE, M.R.C.S.

The principle of this invention consists in giving lateral motion to balloons by utilizing the resistance of the air, during successive ascents and descents, by means of a large triangular sail, placed between the bag and the car at an oblique angle with the horizon; and in rotating them at will by means of a smaller rudder-sail, which is capable of turning on a horizontal axis. The sails are constructed to furl readily.

The principle was first applied to a buoy, depressed to the bottom of a running stream. As it rose it could be made to turn in either direction, according to the setting of the rudder, and would proceed in a course *opposed to the stream* if thus directed, and all by passive means. When weighted it would act similarly during descent. On removal of the weight, it would continue its course whilst re-ascending, and so on. Anyone can experiment for himself, at a trifling cost, in this way.

Provisional Protection was obtained, under date 17th August, 1875 (No. 2,901), and the Provisional Specification contained the following description of the special apparatus:—

1. There is a peculiar arrangement of the ropes supporting the car. The net covering the bag is as usual, but below the belt, bracing the ropes together, the ropes are made to cross, so as to leave three equi-distant open spaces.

2. In the axis of the balloon is a light mast, reaching from a little above the car to a little

below the aforesaid belt. Ropes radiate from one of its extremities to the belt, and from the other to the car, so as to keep it in position.

3. Affixed to the lower part of this mast are sockets for the reception of rods or yard-arms. All the sockets work on hinges vertically.

4. There are three chief yard-arms corresponding to the three open spaces between the ropes. Two of them radiate from the mast horizontally; the third when in position is at an angle with the horizon. The distant ends of these three rods are connected by light cords.

5. Within the space formed by these cords lies the sail, attached both to the cords and to the rods, so that its figure is that of three triangles in one (presenting a concave surface to the resisting air). An opening is left over the car to allow the ropes to pass, and for inspection of the balloon.

6. Pulleys are attached to the upper part of the upright mast, over which cords play for drawing up the yard-arms when furling the sail. The yard-arms are also attached to the car by other cords.

7. The large sail can be reversed by shortening one of the yard-arms (that extending to the apex of the sail), a deeper socket being provided for this yard-arm. The other yard-arms maintain the same position (horizontal) during both ascent and descent.

8. There is a fourth yard-arm capable of being rotated on its axis. This rod passes through a ring at the bi-section of the cord joining the two horizontal arms of the larger sail, and beyond this point bears a fish-tail rudder, which being inclined by rotation more or less obliquely, rotates the balloon in either direction when it is ascending or descending. (When vertical, which is its normal or neutral position, the rudder further serves the purpose of steadying the balloon in its course.)

It should be mentioned that the principle, though independently discovered by the present writer, had occurred, ten years earlier, to Monsieur Menier, of France, who, however, applied it differently, namely, by wings and rudder attached to the widest part of the bag. I was in happy ignorance of this for twelve months.

Now comes the question. How are the continuous ascents and descents, requisite for rendering the invention effective, to be carried out?

Monsieur Menier adopted the old principle of hot-air balloons, and for the purpose employed an enormous Argand burner, with a metallic chimney some 2 ft. in diameter, and by turning the burner up or down he hoped to ascend or descend with ease. But to the best of my recollection, at every experiment on a large scale, the balloon was wrecked by flames.

The principle which commended itself to me, and which answered perfectly in the case of buoys under water, was that of compression and relaxation of the contents of the balloon, or rather balloons, for I employed three of equal size, enveloped in separate nets, braced together by a triangular web at the summit, and having a powerful rope passing from the centre of this to a winch within easy reach of the car. In place of the usual ring or belt, there was a stout framework of rods, forming a horizontal triangle, to which everything was attached, each of the three nets having its special vertex, and the yard-arms of the large sail being at the mid-points of the sides. Under ordinary pressure the balloon would ascend to a sufficient height, and then a few turns of the winch would cause it to descend far enough for working purposes, when liberation would again cause the balloon to ascend, and so on. A small additional pressure per sq. foot would suffice to cause descent through some hundreds of feet.

How Birds Fly.

By T. N. Hugo.

How birds fly, and what is the force employed to sustain and propel them, has been so often discussed that most would think the subject exhaustively explained and thoroughly understood. Yet it is doubtful whether such is the case, seeing that many now are inclined to ascribe the phenonemena of forward flight to the curvature of the surface of the wing. Another view, and a nearly opposite one, is this, that the wing's chief function is that of sustaining, and has but slight propelling property, and what propelling power the curvature of the under surface endows the wing with, is exerted in giving a forward course to the wing itself in its descent; this is the view that will be sought to be worked out in this paper. In allowing that the "curvature" (which, in this paper, is to have the special meaning of "the curvature of the under surface of the wing") is answerable for the forward course of the descending wing, when struck with energy downwards, it does not necessarily mean that

it has any part in the urging forward of the body of the bird, the wings being joined to the body on movable hinges, can have a motion restricted to themselves, and this property of the curvature is supposed to only influence the descending wing. This may appear to diminish the importance attached to the curvature of the wing, leaving out of view the known greater sustaining capabilities of the concave surface, but without a curvature, that is as plain surfaces only, the wings, in their descent, would take a vertical course; now the centre of support, which is underneath the wings, must accompany the centre of gravity of the flying object to sustain it horizontally, the centre of support lagging behind, as would be the case in a vertically descending wing, would cause the body to swing round it and then direct its course head downwards. This gives a sufficient importance to the propelling property of the wing; though restricted to the wing only, it is seen to be indispensable to flight. That the forward direction taken by the wing is automatic, a result of the action of the air on its under surface may be learnt from the dissection of the wing, which shows no special muscle for this purpose, and that the great muscles, the elevator and the depressor, do not explain it either is easily observed by causing the pectorals of a quite freshly-killed bird to work slowly. Moreover, in free flight, a bird when gradually descending with slowly flapping wing, also when the tendency to fall has been to some extent counteracted by a stored up momentum, as in full flight, the wing does not take a forward direction. In these two last cases the wing is elevated and depressed to a very slight extent; the higher the wing is raised the sooner must it be depressed, as with an upraised wing, the body is almost unsupported and begins to fall; that means that it must be energetically depressed, and not until then does this action of the curvature come into play; so the wing unites in its shape an automatic propelling property, the most favourable sustaining surface, the fitting closely to a body moulded to a form to give the least surface to the resistance of the inertia of the air, availed of by the falcon in its swoop and by the gannets and terns in their head-long dives, also the preservation of that advantageous shape when, on the ground, with wings folded, they may be exposed to a strong wind; a striking example of efficiency gained in the simplest manner. That the forward action of the wing does not drag the body of the bird with it, will receive confirmation in the considertion of the following phases of flight. A kestrel while hovering over a meadow or cornfield is seen to beat its wings in a most energetic manner, and although they have a strongly forward course, the bird does not change its position. A pigeon wishing to reach the cave of the farm building under which it has been feeding, does so by strokes of the wing of the greatest amplitude in a downward forward direction, the forward position of the centre of gravity drawn back as much as possible, the body hangs vertically between the joints of the humerus, and the consequence is, that though with energetically forward descending wings, the flight is vertically upwards, these examples, verified by instantaneous photography, though by no means exhaustive, go to prove that the forward course of the wing does not mean the translation of the body of the bird, though it proves its sustension. As there is no doubt that a bird travels in a forward horizontal direction, or in any direction it pleases, and if this is not due to the shape of the wings nor to the speed at which they may be worked, one must look for something else which is as constant a characteristic of a bird as wings, and which is independent of any eccentricities of appendages. This indispensable quality is recognized as the greater weight of the bird to an equal mass of the medium in which it travels, and this is true of every animal which has chosen the same means of progression; it might conceivably have been otherwise, some might have partially lightened themselves by enormously inflated air receptacles, as is now done in a small degree, to terrify their enemies, by some species of lizards, etc.

It can now be stated that the greater specific gravity of the flying object is the cause both of its horizontal flight, of its descending flight, and partly of its ascending-forward flight; of course the weight of the object or animal that is to fly must be in such a ratio to the sustaining surfaces that they are able to elevate and support it; it is in the weight, that we are to find the explanation of forward flight in as mobile a medium as the atmosphere, in which the first great difficulty is to raise and support a weight, and this must and does appear surprising—the wings being limited to elevating, sustaining and guiding surfaces.

The failure of the balloon to travel in any desired direction, is an argument in favour that a greater specific weight than the surrounding air is a necessity; the balloon being of either less or equal specific gravity to the surrounding air, it has either an elevating or sustaining force; but it is only a bubble floating in or upon a current, and quite de-

pendent on that current for its movements. Such a limited power of translation would not suit an animal having to chase or seek its food, and to man, the balloon is of little more use. By those who have made experiments with mechanically driven flying models, weight has been found as necessary as power to raise the model from the ground; it can be seen in the successful free flying models of Professor Langley, L. Hargrave, and Herr Kress, that they have endeavoured not to eliminate weight, but to keep it within reasonable bounds, and to place it in a proper position. This leads to an all important qualification of the above statement "that weight is necessary for forward flight" which is, that "weight in a proper position is necessary." This position is a forward one in the body of the flying object, but how far forward depends on the amount of the support and on the mobility of the supporting surfaces, not merely in taking any angular position, but in amplitude and direction with respect to the position of the forward weight; in other words, an intermittent support. The intermittency of the support is necessary to allow of the position of the centre of gravity to be taken advantage of, otherwise, if the body of the flying objects were continuously supported, either the influence of the position of gravity would be nullified, or if carried far enough forward would merely give the body a list in that direction, but in neither case would horizontal flight be possible; in every phase of a bird's flight is this intermittency of support clearly perceivable, in rowing flight, the intermittency of support is when the wing is raised, which takes about one-third of the duration of the full stroke, and it is to this regularity of intermittency that the high rate of speed can be attained in rowing flight; as momentum is due to the regularity of the recurrence of a motion, it can be equally clearly seen in sailing flight when the bird on outstretched wings is subjected to the intermittent support given by the succeeding air waves, but it is owing to the irregularity of intensity and direction of the air waves that speed in sailing flight is never great.

The short flight and unsatisfactory results of free flying models, which is such a vexation and weariness of spirit to those who have tried to learn anything useful from their flight, is caused by the difficulty of devising means for automatically adjusting supporting surfaces, which would counterpoise at one moment the effect of the weight, at another yielding to it, and again, overcoming it.

A striking example of this play between weight and its support is to be seen by watching a gull advancing against a strong head-wind, slowly floating forward on outstretched wings, which are in closest touch with the instantaneously and constantly changing wind, now with drawing support with half-closed and almost closed wings, and giving full play to its weight as the breeze freshens and as the atmospheric wave ebbs, giving the full support to its grandly outstretched wings, a by no means inspiriting sight, it must be confessed, to the beholder, if he be one who believes and ardently hopes for the solution of the human flight; but there is this to be noticed, that the bird, hovering over a river bearing with its current some of the garbage of a large town, is keenly scanning the surface, and with head turning from side to side; nothing is to be passed that is food. This shows, surely, that the bird's brain is not occupied by the varying intensities of an instantaneously changing support, that all this exquisite balance does not trouble it with a thought. Perhaps this gives some hope that it is not beyond the ingenuity of man to devise as efficacious a combination of weight and support.

It would seem certain that no surface, or grouping of surfaces, can sustain a weight in the air; a fall can be impeded and directed, but not prevented; birds, though provided with the best conceivable surfaces for abstracting support from the air, cannot sustain themselves on outstretched immovable wings; a single wing falls directly to the ground, as do a pair of expanded joined wings separated from the body of the bird. From this it is seen that a wing, in an atmosphere of rest, has no such extraordinary property of sustentation by which it can sustain itself; this support, both for wings and body, is found, either in the forward or upward waves of the atmosphere, more restless even than the great masses of water, which, meeting the under surface of the wing, give up their energy of movement, which directed against the influence of gravity, is sufficient to counteract or more than counteract it, or by muscular energy the wing strikes the air with a speed which, as it were, surprises it into not yielding quickly and the result is a re-action nearly equal to the energy used. In both cases the direction of flight is the direction of the diagonal of the parallel composed of the downward forward force of the centre of gravity and the upward re-action or thrust expressed in the centre of pressure under the wings.

The importance of this position of gravity is seen by the fact that all else is subordinate to it—it determines the speed, therefore the frequency of the beat of the wings. It is not the frequency of the beat of the wings that causes speed, but speed that causes the frequency of the beat of the wings, in other words, the necessity that the wings are under of furnishing a sufficient support in the right direction to a body which by the intermittency of this support has begun through the influence of the position of its centre of gravity to fall forward; to this is due all the different modes of flight.

In the *natatores* the position of the centre of gravity is far forward, corrected, when on the ground by arching the neck backwards. It is so far forward that sailing flight is impossible, and the wings have to be used at a high rate of speed, to give the necessary support, and to disturb the position of that support by as short an interval as possible; the shape of the wings governed by the necessity for speed, are narrow and sharp-pointed, giving the weight of the anterior edge the more preponderance. These birds also have no tail to, in any way, disturb the influence of the position of the centre of gravity; in these birds we see the perfection of rowing-flight.

The *raptores*, on the other hand, are what may be called evenly-balanced birds, a short neck opposing a largely developed tail, the centre of gravity is in but a slightly forward position, their broad wings, nearly the half of their length, are used deliberately, and they are amongst the best sailors; a proportionally large surface being necessary to the flyer relying on the irregular pulsations of the air.

In the first moments of flight, when the bird's efforts are to gain a forward motion, so necessary in order that the wings be carried past the layer of air already disturbed by its stroke on to another which has its inertia to yield, as a re-action or support. In this endeavour the forward position of gravity is of high importance, before momentum can have been acquired, as few birds can raise themselves vertically from the ground; the larger the bird, the less have they this power; the vulture is a fast prisoner in an enclosure, such as a hedge, which prevents it from commencing its flight with a preparatory run. The great amplitude with which the wings are used, when rising from the ground, gives the opportunity to the forward position of gravity to exert its full influence.

The relations between the position of gravity and its support, as they exist in the bird, must be allowed to have this important rôle in flight, viz., that of enabling it to take any desired direction in the air, to which is lent the more probability from the fact that nature generally makes a virtue out of necessity, and in this case has made a virtue out of the intermittent support necessary to the reciproaction of the wing and of the intermittent support afforded by the atmospheric waves and of the greater specific gravity of the flying object. On a first consideration these would certainly appear unpromising means by which flight could be effected; but if nature has thus employed these simple means which are always to hand, to bring about flight, they are deserving of the closest study of the inventor.

With the above views in mind a cursary examination of the various means proposed to enable man to fly will conveniently close this paper. It would seem that if aerial screws are used, vertical screws are only necessary, having a feathering action insuring intermittency of support. If wings, proportionally similar to birds, they must have energy in command to be sure of sustention. It cannot be disregarded that, by this method, finality must be soon reached, though it is probable that it is destined to play the most important role in the infancy of man-flight; balloons and machines with immovable aeroplanes are not practical, but much could be said in favour of a machine that could be partially lightened by means of gas if its bulk could be brought within practical bounds. It will probably not be disputed that if man weighed only 10 lbs., he would have flown long ago; but it is because he weighs usually between 150 and 250 lbs. that, though flight has been a cherished idea for centuries, it has not yet been accomplished. This ought to make those pause before they commit themselves to the belief of the possibility of airships, atlantic-liner size, going at lightning speed through the air.

Koch's Flying Machine.

Herr Koch, who has been experimenting in aerodynamics and with aerial propellers for many years past, has just completed a large model, which is on exhibition in Munich. The machine has two pairs of superposed aeroplanes and a tail, with a large propeller, on the feathering paddle-wheel principle, in the centre. He proposes eventually constructing an apparatus with a total area of about 100 square metres, and a total weight of 600 kilos., provided with a 4-cylinder benzine motor of 24 horse-power.

Wind Averages.

The following tables are extracted from a very interesting paper by Mr. Mossman, published in the Journal of the Royal Meteorological Society :—

TABLE IX.

DIRECTION OF THE WIND AT GREENWICH FROM 1841-90, DEDUCED FROM HOURLY OBSERVATIONS. MEAN NUMBER OF HOURS THE DIRECTION WAS—

Months.	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.
January	60·6	72·8	40·6	58·8	100·0	238·6	91·0	34·3	47·3
February	71·0	85·1	50·0	40·5	71·4	198·3	81·5	40·5	39·4
March	93·7	106·7	68·5	45·1	57·3	182·9	91·0	59·0	39·8
April	88·4	132·7	91·8	46·9	58·2	156·1	70·4	46·9	28·6
May	97·3	147·9	77·1	42·8	60·9	183·5	65·8	33·5	35·2
June	88·2	90·0	56·2	40·0	55·9	219·6	94·6	46·6	28·9
July	74·0	72·8	36·3	27·7	63·5	264·0	115·1	51·7	38·9
August	68·4	68·7	43·3	34·9	62·6	256·8	110·6	47·6	51·1
September . . .	71·0	100·2	47·4	43·8	61·1	212·1	89·6	34·3	60·5
October	73·4	73·4	50·2	54·0	79·8	212·4	98·5	45·3	57·0
November . . .	89·1	78·3	50·4	50·5	80·3	201·1	78·0	47·8	44·6
December . . .	69·9	61·4	44·5	48·0	77·2	235·2	106·4	45·6	55·8
Total . . .	945·0	1090·0	656·3	533·0	828·2	2560·6	1092·5	533·1	527·1

TABLE X.

DIRECTION OF THE WIND AT GREENWICH, 1841-90. MEAN NUMBER OF DAYS IT BLEW FROM THE FOLLOWING DIRECTIONS :—

Months.	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.
January	2·5	3·0	1·7	2·5	4·2	9·9	3·8	1·4	2·0
February	2·9	3·5	2·1	1·7	3·0	8·3	3·4	1·7	1·6
March	3·9	4·4	2·8	1·9	2·4	7·6	3·8	2·5	1·7
April	3·7	5·5	3·8	2·0	2·4	6·5	2·9	2·0	1·2
May	4·1	6·2	3·2	1·8	2·5	7·6	2·7	1·4	1·5
June	3·7	3·7	2·3	1·7	2·3	9·1	4·0	2·0	1·2
July	3·1	3·0	1·5	1·2	2·6	11·0	4·8	2·2	1·6
August	2·9	2·9	1·8	1·4	2·6	10·7	4·6	2·0	2·1
September . . .	3·0	4·2	2·0	1·8	2·6	8·7	3·8	1·4	2·5
October	3·1	3·1	2·1	2·2	3·3	8·8	4·1	1·9	2·4
November . . .	3·7	3·3	2·1	2·1	3·3	8·4	3·2	2·0	1·9
December . . .	2·9	2·6	1·9	2·0	3·2	9·8	4·4	1·9	2·3
Total . . .	39·5	45·4	27·3	22·3	34·4	106·4	45·5	22 4	22·0

TABLE XI.

DIRECTION OF THE WIND AT GREENWICH, 1841-90. MEAN PERCENTAGE FREQUENCY.

Months.	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.
January	8·1	9·8	5·5	7·9	13·4	32·1	12·2	4·6	6·4
February	10·5	12·5	7·4	6·0	10·5	29·3	12·0	6·0	5·8
March	12·6	14·3	9·2	6·1	7·7	24·6	12·2	7·9	5·4
April	12·3	18·4	12·7	6·5	8·1	21·7	9·8	6·5	4·0
May	13·1	19·9	10·4	5·7	8·2	24·7	8·8	4·5	4·7
June	12·2	12·5	7·8	5·6	7·8	30·5	13·1	6·5	4·0
July	9·9	9·8	4·9	3·7	8·5	35·5	15·5	7·0	5·2
August	9·2	9·2	5·8	4·7	8·4	34·5	14·9	6·4	6·9
September . . .	9·9	13·8	6·6	6·1	8·5	29·5	12·4	4·8	8·4
October	9·9	9·9	6·7	7·3	10·7	28·5	13·2	6·1	7·7
November . . .	12·4	10·9	7·0	7·0	11·1	27·9	10·8	6·6	6·3
December . . .	9·4	8·2	6·0	6·5	10·4	31·6	14·3	6·1	7·5
Total . . .	10·8	12·4	7·5	6·1	9·4	29·2	12·5	6·1	6·0

TABLE XII.

SHOWING THE NUMBER OF DAYS OF EACH WIND IN LONDON FROM 1763-1897.

Months.	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.
January	337	405	229	337	567	1336	513	189	270
February	391	472	283	229	405	1120	459	230	216
March	526	594	378	256	324	1026	513	337	230
April	499	742	513	270	324	877	391	270	162
May	553	837	432	243	337	1026	364	189	202
June	499	499	310	229	310	1228	540	270	162
July	418	405	202	162	351	1485	648	297	216
August	391	391	243	189	351	1444	621	270	283
September . . .	405	567	270	243	351	1174	513	189	337
October	418	418	283	297	445	1188	553	256	324
November . . .	499	445	283	283	445	1134	432	270	256
December . . .	391	351	256	270	432	1323	594	256	310
Total . . .	5327	6126	3682	3008	4642	14,361	6141	3023	2968

TABLE XIII.

PERCENTAGE FREQUENCY OF GALES WITH DIFFERENT WINDS, 1763-1897.

Months.	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.
January	7·1	3·5	10·0	2·4	8·6	8·2	18·7	9·0	
February	5·1	2·5	3·9	0·4	13·1	6·8	19·4	8·3	
March	3·2	3·0	9·8	0·0	9·7	8·0	19·3	6·5	
April	3·0	2·3	3·3	0·6	7·7	4·5	10·2	2·6	
May	2·4	2·3	3·0	0·4	5·7	3·9	7·4	5·3	
June	1·2	0·8	0·6	0·4	2·9	2·9	7·4	2·2	
July	1·0	0·5	2·5	1·9	4·3	2·9	6·2	2·0	
August	2·3	0·5	2·5	1·6	6·3	2·1	6·9	1·5	
September . . .	1·5	0·2	3·3	1·2	8·8	4·2	7·6	1·3	
October	2·4	0·7	4·2	1·0	7·4	5·1	15·0	3·9	
November . . .	3·8	2·5	4·6	2·1	10·3	7·8	15·0	4·4	
December . . .	4·9	2·6	8·2	1·5	14·4	8·4	14·0	6·2	
Total . . .	3·04	1·83	4·59	1·20	8·51	5·29	12·11	4·58	

General Mean, 5·11.

NOTES.

Kite-Flying Record.—Again the world's record for kite-flying for scientific purposes has been broken at the Blue Hill Observatory. On February 28th, 12,440 feet above the sea level was reached by a recording instrument attached to a string of tandem kites. This is 365 feet higher than the preceding best record, made at the same place on August 26th. The flight was begun at 3.40 p.m. Tuesday, the temperature at the surface being 40 degs. and the wind seventeen miles an hour. At the highest point the temperature was 12 degs. and the wind velocity fifty miles an hour. Steel wire was used as a flying line, and the kites, four in number, were of an improved Hargrave pattern, with curved surfaces, made after the pattern of soaring birds' wings. The upper kite carried an aluminium instrument weighing four pounds, which recorded graphically temperature, wind velocity, humidity and atmospheric pressure. The combined kites had an area of 205 square feet and weighed twenty-six pounds, while the weight of the wire was seventy-six pounds. The upper kite remained above two miles for about three hours, and was reeled in by a steam windlass, constructed for that purpose. When within half a mile of the ground, the fastening on one of the kites slipped, and this carried it up to the one above, the added pull snapping the wire and sending three kites adrift. A search for the lost kites was begun on Wednesday, and two of them were found at the Milton town farm, about two miles away,

but the third was not recovered until yesterday, when it was found at Field's Corner, over six miles north of the observatory, or more than half the distance between that point and the State House. The recording instrument was found uninjured. This was the last of a series of five high flights made on successive days, Sunday excepted. The average height reached was 10,300 feet, or nearly two miles. The temperature at 10,000 feet on February 23rd was 5 degs.; on the 24th, 1 deg.; on the 25th, 11 degs.; and on the 28th, 20 degs. above zero.

Sailing Balloons. — According to M Hervé, the eminent aeronaut, the invention of a steering sail for balloons, which the newspapers have ascribed to Andrée, dates as far back as 1784, when Professor Kratzenstein, of Copenhagen, some months after the invention of balloons, pointed out that one could use such a sail. Others, and notably Green, the English aeronaut, also considered the steering sail and guide rope. Hervé himself got a deviation of the balloon of 65 to 70 degrees by using this means in 1886. Andrée (1895-97) only obtained a deviation of 10 to 12 degrees. M. Hervé, in conclusion, remarks that such devices can only be regarded as helps, not as the instruments of a regular process of aerial navigation, and that to attempt vast explorations with the possibility of deviating only 10 to 12 degrees appears to him an enterprise as bold as it is inconsiderate.—*The Globe.*

Seventy Miles an Hour for 420 Miles.—A remarkable balloon voyage has been accomplished by three Prussian officers. They left the Tempelhofer-field, Berlin, a few minutes past ten in the morning, the weather being bright, and a strong wind blowing. They crossed the Austrian frontier at a height of 5,200 feet. They were soon over the foothills of the Carpathians, and at four o'clock they landed at Baguska, in Galicia. As the crow flies, Baguska is 420 miles from Berlin. The average travelling would be therefore over seventy miles an hour.

Descent in the Sea.—Madame Charly, the well-known aeronaut, had a narrow escape from death recently. According to a telegram from Nice to the "Petit Journal," she had made an ascent at Beaulieu, and the balloon was carried by the wind towards the sea. Madame Charly opened the valve, and the balloon began to descend very rapidly. Some fishermen went to the balloonist's rescue, and picked her up just as she reached the water.

Artillery versus Balloon.—Recently the German artillery practice with the new quick-firing gun demonstrated that the captive balloon was worthless in warfare when used in the day time. If it can be made available at all, it must be under cover of night, otherwise its shrift is likely to be very short. The German kite balloon was kept moving at an altitude of 600 meters. The guns trained upon it were located 3,000 meters distant. After the third discharge of the rapid-firing battery, the range was found. It was then all over with the balloon, for every shot fired at it reached the mark. It was pierced in all directions and finally set on fire, when it, of course, came quickly to the ground.—*Newcastle Journal.*

M. "Duruof."—The death is announced at Erquelines (Aisne), at the age of 56, of M. Jules Dufour, known as the aeronaut Duruof. He began his ascents with Nadar in 1865, and both of them during the siege of Paris constructed balloons for the Government. At the end of September he made an ascent from Paris with despatches, and alighted near Evreux, but, of course, was unable to return. In 1874, in an attempt to cross over to England from Calais, he and his wife narrowly escaped drowning. He lived latterly on a small Government pension.

A Model Air Ship.—A model of an air ship on the aeroplane system has been constructed by Dr. Barton, of Beckenham. It is a boat-shaped car with wheels underneath it, suspended from a cylindrical balloon, 21 feet long. Between the balloon and the car there is a horizontal aeroplane consisting of a thin flat board, which can be inclined as required. A screw propeller, actuated by clockwork, is fitted to the car. When the balloon is inflated, the aeroplane is sloped upwards in front, the screw is set in motion, and the ship runs on its wheels until it rises. To lower the ship, the aeroplane is sloped in the opposite direction. An experimental run which was conducted in the presence of Colonel Yorke was, on the whole, successful. The machine first ran on the ground upon wheels, then rose and made its way over the lawn-tennis grounds which had been chosen for the theatre of the demonstration. Apparently it cannot go against the wind, but it is evidently capable of being directed more closely than the ordinary balloon.

A new Balloon Gun has been invented. It is mounted on a waggon, and so placed upon "universal" bearings as to be aimed instantly at any point from zenith to horizon. After the

manner of the machine weapon, it throws a continuous stream of projectiles, like water turned on from a hose, and no gas bag exposed to its discharge for many moments could possibly stay aloft. The projectiles are conical and of solid steel, having no bursting charge, and weigh a pound apiece. A hollow conical stand fastened to the floor of the waggon supports the gun, the arrangement being such that when it has to be aimed directly upward the marksman must lie beneath it. Its effective range is a mile and a quarter.

A Swiss Dirigible Balloon.—The balloon is shaped like a fish or boat, and is 16 metres long, 4 wide, and 8 high. Its concavity contains about 300 cubic metres. Inside there is a wooden frame covered with aluminium plates rivetted together and cemented. Three specially constructed lamps, in the lowest part of the concavity, supply the balloon with warmed and, consequently, rarefied air, to raise the weight, which is reckoned at 1,000 kilogrammes, including the two aeronauts. Right and left outside the vessel two windmill-like sails, having a surface of two square metres, are set, which can be propelled by hand from the driving chamber. The screw sails, together with the rudder at the after part of the balloon, should enable it to be turned as desired From a valve fixed on the top cold air can be let into the balloon, thus causing it to descend. This interesting construction is almost ready, and Herr Weisenrieder will shortly make an ascent.

Gyration of Aerial Machines.—Count J. Carelli has recently been writing several interesting articles in *La France Aerienne*, and elsewhere on the above subject. This action, caused by the minor currents of the atmosphere, is frequently noticeable in ordinary balloon ascents, and has proved a difficulty in the trials of propelled balloons. Count Carelli states that "a body immersed in a fluid turns more easily as the fluid is less dense," and therefore is more noticeable in air than in water. He has recently devised an apparatus which he terms "a dirigible parachute," to experiment on means for overcoming this tendency. In the centre of this is fitted a disc to be rapidly rotated, and the centripetal force thus created should preserve the balance. The model tested was in the form of a curved rectangle, about 5 ft. by 2 ft., with a propeller behind and a gyroscopic disc in the centre worked by clockwork. The results of the experiments are said to be very satisfactory, the model remaining perfectly horizontal during its descending flight.

Recent Publications.

"Soaring Machines." By L. Hargrave. (Reprinted from the Journal of the Royal Society of N.S.W.) Another interesting account of experiments with models of a new form. We shall hope to be able to reproduce this article in a future number.

"Grundlagen der Lufttechnik." By Max Lochner. (Berlin: W. H. Kuhl, 1/6.) A popular treatise on a new theory for the solution of the question of flight and the problem of dirigible balloons.

"Studies of Cyclonic and Anti-Cyclonic Phenomena with Kites." H. Helm Clayton. Blue Hill Meteorological Observatory, with tables and diagrams.

"Progress of Experiments with Kites during 1897-98 at the Blue Hill Meteorological Observatory." S. P. Fergusson. With illustrations and diagrams.

Foreign Aeronautical Periodicals.

L'Aeronaute (Paris).

January.—Séances du Comité d'Aérostation pour l'exposition de 1900—Ascension de l'Alliance (6 planches)—Compte rendu technique du ballon captif de Turin, par M. Louis Godard—Ascensions exécutées a l'aérodrome, par l'Aérostatic Club—Correspondence.

February.—Compte rendu du Comité de l'exposition de 1900—Lettre au Ministre de Affaires Etrangeras sur l'interdiction des ballons en temps de guerre—Ballon dirigible de M. Danilewski (2 planches, photographiques)—Société française de Navigation aérienne.

March.—L'inconstance Solaire, M. Hauvel—Etude de la haute atmosphère—M. de Fonvielle—Rapport sur le Moteur Paloux*—M. Cassé—Société française de Navigation aérienne — Nécrologie, Jules Dufour — le General de Bouedec.

* This is on the principle of the Turbine, using either steam or petroleum vapour.

LA FRANCE AERIENNE (Paris).

January 1-15.—Lettre ouvert au Comte Carelli: C.Jobert—Humorismé aéronautique: Comte Carelli.

January 15-31.—De la Giration dans l'Air—Compte rendu technique du ballon captif de l'exposition de Turin—Academie d'Aérostation Météorologique—Tableau de diverses vitesses.

February 1-15.—Aéronautique théorique et practique — Comte Carelli — Académie d'Aérostation Météorologique—Tableau de diverses vitesses (suite and fin).

February 15-28.—La France Aérienne en Amérique.

March 1-15.—Ballon dirigible et boulet de cannon, Comte Carelli—Nécrologie, Duté Poitevin—l'Aéronautique en Italie—Météorologie Populaire, Pronostics du Temps.

March 15-31.—A la Conquète de l'Air C. Jobert—Aéronautique au jour le jour: Comte Carelli—Nécrologie, Jules Dufour (Duruof)—Expériences exécutées avec un parachute dirigible du Comte J. Carelli (illustrated)—Action Simultanée de plusieurs aérostats comme nouveau systéme de Navigation aérienne, M. Sigaline.

ZEITSCHRIFT FUR LUFTSCHIFFAHRT (Berlin).

January.—Abschiedswort: A. Berson (Dr Berson has given up the editorship of this journal, and Herr Karl Milla, of Vienna, has succeeded him)—Zum Eintritt, K. Milla—Jäger, Zur Frage des Widerstandes, welchen bewegte Korper in Flussigkeiten und Gasen erfahren—V. Loessl—Der Aërodynamische Schwebezustand einer dünnen Platte—Kleinere Mittheilungen.

ILLUSTRIRTE AERONAUTISCHE MITTHEILUNGEN (Strassburg).

January, 1899. — Versuche mit neuen Registrir-Drachen, von Hugo L. Nickel—Der automatische Flug mittels des Kress-Fliegers, von Arnold Samuelson—Die Militarluftschiffahrt in England, von H. W. L. Moedebeck—Einige Erfahrungen aus den Freifahrten des Jahres 1898, von Hinterstoisser—Die Ballonfahrt über die Alpen am 3 Oktober 1898—Kleinere Mittheilungen: Bau der russisehen viereckigen Drachen, von Hüther; Der hochste Drachenaufstieg, von A. Lawrence Rotch; Lamson's Drachen; Das Luftschiff von de Santos Dumont; Die Luftschiffahrt auf der Weltausstellung zu Paris im Jahre 1900; Bericht uber die Thatigkeit der Abtheilung fur Luftschiffahrt auf dem X. Kongress der russischen Aerzte und Naturforscher in Kiew im Jahre 1898, von A. Kowanko—Aus unseren Vereinen—Aus anderen Vereinen—Patente in der Luftschiffahrt—Eingegangene Bucher und Separatdrucke — Zeitschriften-Rundschau — Aus anderen Zeitschriften—Neue Nachrichten—Personalien—Briefkasten.

Notable Articles.

Jan. 1899. *Geographical Journal.*—"A new Mountain Aneroid Barometer." E. WHYMPER. An important communication dealing with the errors of ordinary aneroids for measuring heights.

6. *Daily Telegraph.*—"Ships of the Air." General account of the progress of aeronautics during recent years.

7. *Golden Penny.*—"Adventures in the Air.' By S. SPENCER. The Sensations of Parachuting. (Illustrated from photographs.)

7. *Adelaide Observer.*—"Modern Balloons."

14. *Golden Penny.* — "Adventures in the Air." By STANLEY SPENCER. Illustrated account of the high ascent with Dr. Berson.

20. *English Mechanic.*—"Danilewski Dirigible Flying Machine." (Illustrated.)

Feb. *Pall Mall Magazine.*—"European Military Ballooning." A. DELMARD and R. BLATHWAYT. (Illustrated.) Gives an account of the French establishment at Meudon, and the navigable balloon "La France," followed by a description of the English establishment. The article is full of inaccuracies; thus plate V. represents Debayeux's balloon, not "La France." The motor used in the latter does not weigh "four times less than any other known combination used in attemps to navigate the air." The English "Balloon Corps" is at Aldershot, not Chatham, and the hydrogen produced there is from zinc, not iron. The story of the Boer Campaign is amusing from its errors. Finally it is said that "the Germans do not appear to take much interest in this science"!

Feb. 4. *Revue Scientifique.*—"Les ballons à deviateurs." H. HERVE.

4. *Invention.*—"A Nearly Successful Flying Machine." Danilewsky's Dirigible Balloon. (From *Aeronautical Journal.*)

10. *English Mechanic.*—"Myer's Sky Cycle."

12. *Manchester Sunday Chronicle.*—"Balloons in War and Peace." Sailing balloons, &c. (Illustrated.)

16. *Standard.*—Leading article on Scientific Ballooning.

17. *Westminster Budget.*—"The Fate of Andrée."

18. *Society.*—"Ballooning."

18. *Penny Magazine.*—"Aerial Photography."

22. *Electrical Review.*—"Experiments with Kite Electric Collectors." W. A. EDDY.

Mar. 11. *Graphic.*—"Military Ballooning at Aldershot." With photographs of model Kite-balloon.

11. *Pearson's Weekly.*—"Shall we Fly in 1900?"

12. *New York Herald.*—"Flying Machines." (Illustrated.)

21. *Scotsman*—"The Exploration of the Atmosphere by means of Kites.

Applications for Patents.

(*January, February, March*, 1899.)

2,257. February 1. H. SUTER, Manchester. Improvements in Air Ships. (*Complete.*)

3,116. February 11. J. P. GIVORD, London. Advertising Balloon or the like.

3,637. February 18. A. H. P. BLUNT, London. An Improved means of Aerial Sailing.

3,892. February 21. R. M. BALSTON, London. Improvements in Flying Machines.

5,094. March 8. E. BAKER, London. Improvements in or connected with Navigable Balloons or Flying Machines.

5,418. March 13. F. A. BARTON, Beckenham. An Improved Aerial Machine or Air Ship.

Patents Published.

18,935. August 16, 1897. Flying Machines. HARDACRE, G., Lower Bucca, New South Wales.

The frame consists of a vertical standard having a spring base and carrying a motor, a platform propeller gas bag, and a pair of wings with articulating bars. A second standard, to which is attached an aeroplane, can slide in guides upon the standards, and is reciprocated by the motor. The propeller is driven through gearing and connecting rods. The wing arms are pivoted on a cross-bar.

18,992, 19,301, 20,434, 20,909, and 21,308 are abandoned.

21,355. September 17, 1897. Steering Balloons. BROOKES, A. G., 55, Chancery Lane, London.—(*Bagge, P. I.; Risor, Norway.*)

There is a sail with a horizontal cylinder having its axis in the plane of the sail. A fan at the rear end of the cylinder causes the balloon to travel through the wind in a rearward direction, and produces through the cylinder a current which acts on an adjustable rudder tending to keep the sail slightly inclined to the wind, and consequently to cause the balloon to move sideways.

23,563, 23,655, and 24,133, abandoned.

24,532. October 22, 1897. Flying Machines. DANILEVSKY, C., Hydropathic Institute, Veterinary Street, Kharkow, Russia.

From an aerostat of not quite sufficient buoyancy to support a man in the air, is suspended by cords a frame carrying a saddle and wings. The aeronaut is supported on the saddle, and with his arms and feet works the wings. One of the cords is attached to a winch and can be varied in length, so that at starting the aeronaut is in a vertical position and can run along the ground on stilts, while, when he has ascended, by lengthening the forward cord he can assume an inclined or a horizontal position. The inclination of the axis of the aerostat may also be altered by shifting the position of the pulley by which the aeronaut is suspended by means of cords. The wings have main arms of bamboo, pepper-vine or the like, made in short pieces hinged together by spring hinges, so that the arms can bend on the up-stroke; the transverse arms are prevented from becoming inverted by cords. The wings are supported by a spring. The direction of the wings may be varied by a lever working over a slotted disc.

24,590, abandoned.

26,391. November 12, 1897. **Aeronautics; road vehicles.** WOLFF, CARL, BARON VON, Dresden, Dornblüthstr. 1B.

For raising and propelling aerial machines, or assisting in the propulsion of road vehicles, a number of arms on an axle, driven by a motor or from the wheels of a vehicle, are provided with jointed extensions carrying weights at the end. Opposite extensions are connected together by pulleys and bands, so that on one side they are opened outwards and on the other drawn in against the axle by a pulley acting upon a lever as the apparatus is rotated. The direction of motion or of the force exerted is stated to be that in which the centrifugal power produces its principal effect, and this direction can be altered by shifting the position of the axle of the pulley in the slotted arm of the standard. In one modification, weighted levers are pivoted to a cross-piece and are allowed to swing outwards, during a portion of their rotation round the axis, by means of a surrounding cam-box. In another modification, opposite weights are mounted on the same rod, which slides in guides across the axis, the weight at one end being guided by a curved race.

28,810, abandoned.

United States Patents.

621,195. **Navigable Balloon.** F. G. ZEPPELIN, Stuttgart, Germany.

Framework divided into compartments, with gas bag in each, also auxiliary gas bags for manœuvring. Adjustable weight to preserve balance. Foremost balloon provided with driving mechanism.

621,593. **Kite.** WALTER S. BAKER, Newark, N.J.

Diamond-shaped kite. Two sticks with slots at ends to take cords fixed to the sides of the covering. Longitudinal pocket for backbone.

French Patents.

280,021. LOCHNER. **Improvements in Aerial Vehicles.**

280,582. LAUGHLIN. **Improvements in Apparatus for Elevating and Propellers for Aerostats.**

280,593. LANGE. **Dirigible Air Ship.**

280,698. KOBYLANSKI. **Dirigible Air Ship.**

281,310. DUPUIS. **Direction of Aerial Machines by the Combination of Heavier and Lighter than Air.**

282,353. CZARNIAKOWSKI. **Pneumatic Screw to solve the Problem of Aerial Navigation.**